Network-based Navigation

Completed Technology Project (2012 - 2012)

Project Introduction

With the expansion of communication assets into planetary networks, such as the Mars Network, there exists a great opportunity to integrate a new solar system-wide navigation system.Initial networks, such as Mars Reconnaissance Orbiter (MRO) operating as a communications relay for Mars ground-based assets, show that the capability exists for such a distributed networking system. Research into Delay-&Disruption-Tolerant Networking is developing a protocol for high-bandwidth reliable communication

There is a range of navigation techniques in use for spacecraft in deep space. Traditional techniques involve optical navigation, in which the bearing and range (or multiple bearings) to a celestial object(s) are combined with known ephemeris information to calculate a position fix. The application of this method is constrained by the optical observation capabilities. There is also a requirement for ground support to analyze the optical images and compute the navigation fix. Research into Autonav moves this analysis onboard the spacecraft, at the cost of a large a priori knowledge requirement and increased mission planning to tell the spacecraft when and where to point in order to capture observations for a navigation fix. This capability is also limited by knowledge of the observed objects' ephemeris. Another method is to use radio waves to determine range and radial velocity. The range is calculated by measuring the time it takes a tone to travel to the spacecraft and return to the ground (two-way ranging) and radial velocity is measured by capturing the Doppler shift inherent in the received signal (of an initially known frequency). The angular position in the sky is captured by antenna tracking techniques which utilize specialized hardware and software to analyze the power of the received signal. This measured angular position can be improved by DDOR techniques, which utilize multiple antennas and observations of a known source to capture errors, to the order of nanoradians. This process is very sophisticated, requires a large amount of ground hardware and analytical support. Research into software-defined radios has developed the Electra instrument, which can perform in-orbit radiometric ranging and Doppler tracking. Currently this is only implemented on UHF radios, which limit the range and applicability of the solution. Additional methods utilize dead reckoning and measurements of the intrinsic state through highly accurate inertial navigation units.

Anticipated Benefits

Implementation of this technique will provide an autonomous software-based navigation technique to reduce ground support costs while maintaining accurate onboard solutions, and improve accuracy of navigation deep into the solar system by taking advantage of a network of space assets, without the need for additional spacecraft hardware systems.

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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Marshall Space Flight Center (MSFC)

Responsible Program:

Center Innovation Fund: MSFC CIF

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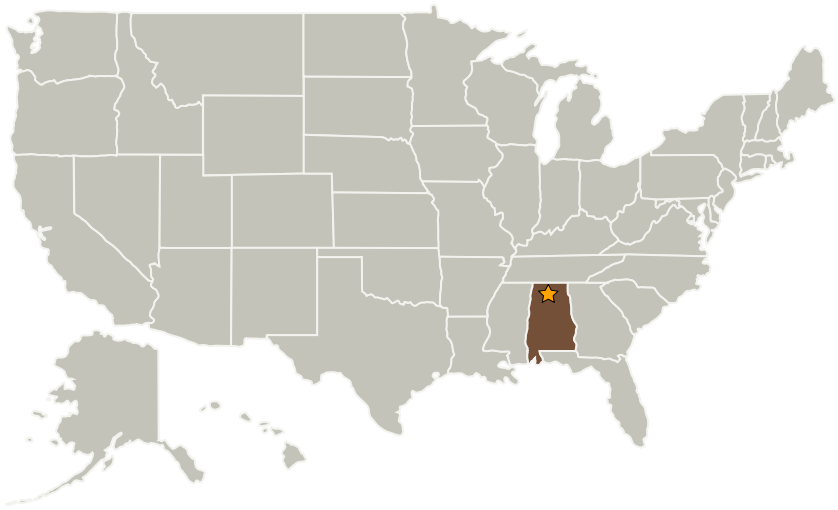
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Marshall Space Flight Center(MSFC)	Lead Organization	NASA Center	Huntsville, Alabama

Primary U.S. Work Locations
Alabama

Project Management

Program Director:
Michael R Lapointe

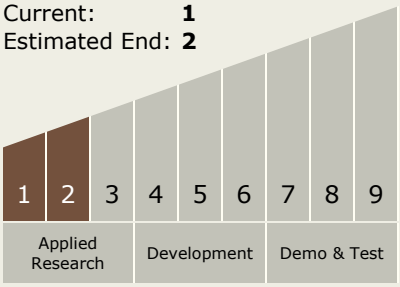
Program Manager:
John W Dankanich

Project Manager:
Evan J Anzalone

Principal Investigator:
Evan J Anzalone

Technology Maturity (TRL)

Start: **1**
Current: **1**
Estimated End: **2**



Technology Areas

Primary:

- TX05 Communications, Navigation, and Orbital Debris Tracking and Characterization Systems
  - TX05.1 Optical Communications
    - TX05.1.6 Optimetrics